

THE ORIGIN AND COURSE OF WEST INDIAN HURRICANES.

By JOSÉ CARLOS MILLÁS.

[Author's abstract.]

In this paper the results obtained by Father Viñes and the data of the recent investigations carried out by the meteorologic service of the United States are made use of in the study of the above topic. The author thus determines the regions most frequented by this class of cyclones. He points out the fact that there are several anomalies which indicate great variation in the causes and suggests that these variations be studied. The only definite statement the author makes in regard to the causes is that these storms have their origin in a parabolic zone which extends from the Cape Verde Islands to the Gulf of Mexico. He also notes that at the beginning of the hurricane period, the points of origin tend to be in the western part of the zone, while in the middle of the season, at the time of greatest frequency, the points of origin are more likely to be in the eastern part.

The author then takes up the problem of the origin and course of hurricanes. He says that from the theories that attempt to explain the formation of the phenomena arises the modern tendency to ascribe the initial moment of the cyclone to the dynamic hypothesis. He believes that many tropical storm phenomena are better explained by a modified hypothesis of condensation.

He calls attention to the solution proposed by Davis: Solar energy which gradually accumulates in the interior region of the atmosphere; the calm preceding the gyratory movement and the influence of the rotation of the earth. To these he adds the influence of opposing currents of different temperatures. He thinks that the opinion of Bigelow also must be considered. That the first movement of the whirl takes place in the upper strata in the zone between the high stratus and the cirrus.

From these considerations he draws the conclusion that the problem is far from being solved.

The author raises the following questions: (1) Does the gyratory movement descend or ascend? (2) If it ascends, does it always find suitable conditions for its development? (3) If it ascends, do the upper currents always provide the necessary elements for its development?

On taking up the course of hurricanes the author indicates what the normal path is in the different epochs and lays down practical rules to guide the observer. He considers also the forces which drive the storm in its parabolic course, one of which, the upper current, appears to have a special influence.

Finally he considers the course from the mathematical point of view, arriving at the conclusion that up to the present time the results of the studies made are more imaginary than real.

INVESTIGATIONS OF FORECASTS OF BAROMETRIC VARIATION.

By SIMÓN SARASOLA, S. J.

[Author's abstract.]

The author begins by establishing the fact that every rational forecast of the weather must depend upon a prediction of high and low pressure, since otherwise there can be no solid basis for a forecast. In the development of this proposition he reviews the different methods employed in the formulation of forecasts.

The author then turns to his personal investigations in this field. The periodicity of barometric variations may be studied from two points of view: (1) Examining the maximum and minimum pressures in a given locality to discover whether there really exists a periodic law by which it is possible to forecast the day on which the barometer will rise or fall; (2) studying the variations of pressure by means of the weather map over extensive regions.

The author believes that the forecasting of changes in atmospheric pressure may be made use of in relation to the hurricanes of the West Indies and he makes a brief reference to the isobaric method, formulating the following propositions: (1) "Atmospheric pressure suffers a periodical change. The approximate value of the period is 30 days; (2) the depressions, whether deep or not, appear periodically. The tendency to fall is noticed every 20 days." To prove these propositions the author gives a table of the most important hurricanes which have occurred from 1896 to 1915 in the West Indies, indicating the barometric readings in the Observatory of Belén in Habana.

The author says that it is possible to calculate when the barometer will fall, but not how much, and that on the day when this may be calculated with exactness the problem of barometric variations will be solved. He says that with his method he has been able to forecast with precision during the last 10 years the day on which the barometer would fall and when it would begin to rise. In this connection he refers to the cases published in the annals of the Observatory of Montserrat, No. 1, page 32.

The author next considers the method applied to the weather maps, especially those of Washington. He believes that the high and low shown on these maps do not always indicate notable atmospheric dis-

turbances, it being necessary many times to consider them in relation to the barometric reading of the nearest station; nor are they of special interest in the study of the depressions of some intensity. In his opinion the work of the Weather Bureau of the United States in the study of the course of cyclonic disturbances, their different types, etc., is very useful and helps to form an idea of the greater or less probability of the appearance of depressions in a given region.

ATMOSPHERIC ELECTRIC OBSERVATIONS ABOARD THE "CARNEGIE," 1915.

By W. F. G. SWANN.

[Author's abstract.]

This paper treats of the instrumental equipment and results of the observations made aboard the magnetic survey vessel, the *Carnegie*, of the department of terrestrial magnetism of the Carnegie Institution of Washington, during the portion of her 1915 cruise extending from Brooklyn to Alaska, via Panama and Honolulu.

The atmospheric-electric measurements aboard the *Carnegie* are as follows:

- (1) The potential gradient.
- (2) The conductivities λ_+ and λ_- arising from the positive and negative ions, respectively.
- (3) The numbers of positive and negative ions per cubic centimeter (n_+ and n_-).
- (4) The radioactive content of the atmosphere.
- (5) The radioactive content of the sea water.
- (6) The number of ions (R) produced per cubic centimeter per second in a closed vessel.

The following meteorological observations are made; Pressure, temperature, and humidity. The diurnal variations of the potential gradient, conductivity, and ionic content are also under investigation.

For potential-gradient measurements, the apparatus employed comprises a long brass tube, carrying a parasol attachment at one end, and mounted on insulated bearings fixed to the stern rail of the ship, so that it may be turned in a vertical plane containing the fore-and-aft line. Relative values of the potential gradient are obtained by measuring the alteration in potential which the insulated system undergoes when it is turned through a fixed angle from an earthed position.

For measuring the conductivity, the method of Gerdien, somewhat modified, is employed, and for measuring the ionic content a modification of Ebert's ion counter is used. The quantity R is obtained from the saturation current measured in a closed vessel, and the radioactive content is deduced from observations on the amount of active material collected in a given time when air is drawn through the space between two concentric cylinders, the central member of which is raised to a high negative potential.

The results for the Pacific Ocean are naturally the more interesting since here the vessel was on the average a considerable distance from land. The mean 9:30 a. m. value of the potential gradient over the Pacific Ocean is 116 volts per meter, while the mean value for the same time of day and year as obtained from nine land stations, is 149 volts per meter. The mean values of $n_+ + n_-$ and $\lambda_+ + \lambda_-$ are, respectively, 1,600 and 2.91×10^{-4} e. s. u., which are somewhat larger than the values 1,480 and 2.29×10^{-4} e. s. u. corresponding to the means for several land stations. The mobilities of the positive and negative ions are respectively 1.3 and 1.4 cms. per second per volt per cm.

The radioactive content of the air over the Pacific Ocean forms only about 2.5 per cent of the average value over land and is too small to be of any appreciable influence in determining the number of ions per c. c. The value of R for the Pacific Ocean is 3.9, and is more than sufficient to account for the observed ionization, but uncertainty must necessarily exist as to the portion of this amount attributable to the vessel itself.

The most striking feature presented by a comparison of the ionic content over land and sea is that the former is no greater than the latter in spite of the known extra cause for ionization to be found in the radioactive material in the former case. It is suggested that the greater rate of production of ions over the land is more than offset, as regards the measured ionic content, by the greater proportion of the ions which are there converted to the slowly moving, unmeasured type, by combination with dust nuclei.—W. F. G. S.

THE WEATHER AND CLIMATE OF SALT LAKE CITY, UTAH.

By ALFRED H. THIESSEN.

[Author's abstract.]

The climate of Salt Lake City, Utah, is interesting in many points—the relatively high annual mean temperature, mild winters, hot but agreeable summers.

Salt Lake City is 4,300 feet above sea level, protected by mountains on its north and east sides. The mean annual temperature is 51.7° F. The highest temperature ever observed was 102° and the lowest —20°. During 41 years of records there were only 5 years when maximum

temperature rose above 100° and 14 years when the minimum temperature fell below 0°F.

The average temperature for the seasons is as follows: Winter, 31.6°; spring, 49.7°; summer, 72.3°; and fall, 52.5°.

January is the coldest month, with a mean temperature of 29.4°; but the lowest average monthly temperature is credited to February, 1903, which was 20°. The warmest month is July, whose mean is 75.4°.

There are 89 rainy days in Salt Lake City, and the average annual precipitation is 16.24 inches. The wettest year was 1875, when 23.04 inches were measured; the driest in 1890, 10.33 inches. April is normally the wettest month and July the driest. No excessive rainfall ever occurs in Salt Lake City. The greatest 24-hour amount was 2.72 inches, in May, 1901. The heaviest rain in one hour was 0.91 inch, on July 19, 1912. The average snowfall is 50.6 inches, most of which falls from December to March, inclusive.

In general, the climate is agreeable when one considers the effect of a year's experience. The warm summer days are accompanied by low humidities, followed by cool nights. The winter temperatures are sometimes quite low, but never for long periods.

CLIMATIC CONTROL OF CROPPING SYSTEMS AND FARM OPERATIONS

By J. F. VOORHEES.

[Author's abstract.]

The object of this paper is to prove that all successful cropping systems must be based on climatic conditions.

By cropping systems we refer to the number of crops that are grown successively on the same ground in one year, as a one-crop system or a two-crop system.

Climatic control may be positive or negative. Negative control is exercised when climate prevents us from growing more than a certain number of crops and when it permits us to grow a certain number of crops. Positive control is exercised when climate penalizes us for failure to grow as many crops as possible.

The climatic factors considered are rainfall, length of growing season, and heat intensity. Variations of these factors give us a great variety of climates, as the continuous-crop climate, the two-crop climate, the one-crop climate, and the no-crop climate.

Negative or preventive control is exercised in all but the continuous-crop climate, while positive control is exercised mainly in those regions where more than one crop can be grown.

Temperature controls our crop successions and our farm operations through control of the length of time required for the growth and maturity of both plant and insect life.

The penalty for failure to use a proper cropping system is loss of the farm. This is proved by the fact that many worn-out farms have been reclaimed by proper cropping systems.

To comply with the demands of climate more knowledge of the relationship between plants and animals on one side and climatic conditions on the other is needed. This knowledge can best be obtained through cooperation.

THE THUNDERSTORMS OF THE UNITED STATES AS CLIMATIC PHENOMENA.

By Prof. ROBERT DeC. WARD.

[Author's abstract.]

As essential characteristics of American climate, thunderstorms have a broad human interest. From the viewpoint of climatology, the distribution of thunderstorms is of more interest than their mechanism. The part played by their rains in watering our crops is of greater importance than the size of the raindrops. The damage done by their lightning and hail concerns us more than the cause of the lightning flash or than the origin of the hailstones. The thunderstorms of the eastern United States are among the most characteristic of American climatic phenomena. In size, intensity, and frequency of occurrence they are unique.

No part of the country is entirely free from thunderstorms, but the two regions of greatest activity are in Florida and in northern New Mexico. It is over the immense area east of the Rocky Mountains that our great State-wide thunderstorms occur, which often last for many hours, and may cover a territory stretching from the Mississippi Valley to the Atlantic coast. Throughout this area also, on hot summer afternoons, hundreds of scattering sporadic thunderstorms often occur, of local importance because supplying rain. These local storms are more frequent in southern than in northern sections, and as a whole the northern tier of States has distinctly fewer thunderstorms than the southern.

The thunderstorms of the mountains and plateaus of the West are chiefly sporadic and short-lived. They supply the rainfall of the higher elevations, commonly known as "islands" of rainfall, though obviously more appropriately termed "lakes." On the Pacific slope thunderstorms are not often experienced on the immediate coast, but occur

more frequently in the interior valleys and on the mountains. They are characteristic summer phenomena at the greater elevations and furnish much or all of the "dry season" rainfall of those localities.

In relation to man's activities, it is of significance that most thunderstorms occur at the time of year and at hours when outdoor activities are at their height. The Southern States may be said to be in the thunderstorm belt all the year. As spring and summer come on, this belt moves northward. Taking the country as a whole, July brings most thunderstorms. Late spring and early summer bring considerable thunderstorm rainfall of marked economic importance over the eastern Rocky Mountain foothills and the Great Plains, while over the plateau region thunderstorms are most frequent in late summer. On the Pacific slope the inland thunderstorms show a preference for summer; the rarer ones of the immediate coast develop chiefly in winter.

A broadly generalized composite weather map is given, showing conditions under which "cyclonic" thunderstorms are likely to occur over the area from the Mississippi Valley eastward, and another map, also generalized, shows conditions favorable for the development of "heat" thunderstorms over the eastern United States.

Thunderstorms bring us much that is of benefit. To them we owe much, in parts of our country even most, of our spring and summer rainfall. Without these beneficent thunderstorms our great staple crops east of the Rocky Mountains would never reach maturity. One good thunderstorm over a considerable area at a critical crop stage is worth hundreds of thousands of dollars to American farmers. Our stock markets time and again show the favorable reaction of such conditions upon the prices of cereals and also of railroad and other stocks. Thunder-showers break our summer droughts, cleanse our dusty air, refresh our parched earth, replenish our failing streams and brooks, bring us cool evenings and nights after sultry and oppressive days.

THE ECONOMIC ASPECT OF CLIMATOLOGY.

By EDWARD LANSING WELLS.

[Author's abstract.]

The economic status of the individual depends to a degree upon his environment and upon his ability to select a favorable environment or to make the most of that which is inevitable in his environment. Natural resources constitute a part of one's environment, and climate is an important natural resource.

Climate is intimately related to agriculture, engineering, transportation, commerce, manufacturing, health and efficiency, recreation, safety, and to practically every human activity.

It controls the distribution of vegetation, both as to kind and quantity, and successful agriculture depends upon a knowledge of climatology and how to make the best of existing conditions. Its relation to agriculture is indirect as well as direct, having to do with problems of irrigation, drainage, transportation, manufacturing, marketing, and the efficiency of labor, as well as with the control of insect pests and fungous diseases.

In engineering work climatology is of value in the development of water power and wind power, in the construction and maintenance of transmission lines, whether for power or for communication, in construction and operation of irrigation systems, in the construction of buildings, bridges, railroads, water-supply systems, sewers, and heating and refrigeration plants.

Few commodities are used where they are produced, and climatology enters largely into most of the problems of transportation. Sailing routes are laid out so as to take advantage of the great wind systems and to avoid storm tracks and fog areas. Floods, deep snows, high winds, etc., are to be considered in laying out railroads, and perishable freight must be protected in accordance with existing and expected weather conditions. Claims for damage to perishable freight and for car demurrage are often settled on the basis of weather records. Climate should be carefully considered in building and maintaining automobile roads.

The price of commodities, property, and labor depends to a certain extent upon supply and demand, and both supply and demand are affected by the climate. The prices of foodstuffs may vary rapidly under the influence of weather changes. Insurance rates are based, in part, upon the showing made by the weather records, and life insurance companies sometimes refuse policies to residents of States known to have an unhealthy climate. The distribution of many commodities, such as clothing and farming implements, is governed by the demands of the climate. Advertising, routing of salesmen, the location of distributing depots, and the pressing of collections depend upon weather conditions. The means of commercial communication are often good or bad, as the climate is favorable or unfavorable. In the storage of perishable products, studies of the climate are absolutely necessary. Conventions and fairs, having a commercial value to the localities where held, are attracted to places where the climate is known to be favorable.

Many manufacturing industries are regional because they demand certain climatological conditions. Among these may be mentioned the manufacture of tobacco products and textiles. The character of the